HLW MANAGEMENT AND TECHNETIUM-99 PROBLEM

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Technetium-99 is formed in uranium-235 fission with the yield of 6,161 % [1]. Its activity is given in the Table 1 in comparison with the activities of the other long-lived fission products. It is seen that the activity of technetium-99 will be more than those of other fission products in the period between 380 and 600 000 years.

Table 1

Activities *A* of long-lived fission products, Bq/t U

Radi-onuc-lide	$Ò_{1/2}$ Years [1]	Dose coeffi-cient å, Sv/Bq [2]	A_{500} å, Sv	Activities *A* after time of storage, years		
				0	500	1000
^{137}Cs	30.17	$2.0\ 10^{-8}$	800	$4\cdot10^{15}$	$4\cdot10^{10}$	$4\cdot10^{5}$
^{135}Cs	$2.3\cdot10^{6}$	$2.0\ 10^{-9}$	30	$1.5\cdot10^{10}$	$1.5\cdot10^{10}$	$1.5\cdot10^{10}$
^{79}Se	$4.8\cdot10^{5}$	$2.0\ 10^{-9}$	28	$1.4\cdot10^{10}$	$1.4\cdot10^{10}$	$1.3\cdot10^{10}$
^{129}I	$1.6\cdot10^{7}$	$1.0\ 10^{-7}$	92	$9.2\cdot10^{8}$	$9.2\cdot10^{8}$	$9.2\cdot10^{8}$
^{151}Sm	93	$2.0\ 10^{-10}$	32	$7.2\cdot10^{12}$	$1.6\cdot10^{11}$	$3.8\cdot10^{9}$
^{126}Sn	$2.3\cdot10^{5}$	$6.7\ 10^{-9}$	33.5	$5\cdot10^{9}$	$5\cdot10^{9}$	$5\cdot10^{9}$
^{107}Pd	$6.5\cdot10^{6}$	$6.7\ 10^{-11}$	29.5	$4.4\cdot10^{8}$	$4.4\cdot10^{8}$	$4.4\cdot10^{8}$
^{99}Tc	$2.1\cdot10^{5}$	$6.7\ 10^{-10}$	375	$5.6\cdot10^{11}$	$5.6\cdot10^{11}$	$5.5\cdot10^{11}$
^{93}Zr	$1.5\cdot10^{6}$	$2.9\ 10^{-10}$	23	$8.0\cdot10^{10}$	$8.0\cdot10^{10}$	$8.0\cdot10^{10}$
^{90}Sr	28.64	$3.3\ 10^{-8}$	1287	$3.9\cdot10^{15}$	$2.1\cdot10^{10}$	$1.2\cdot10^{5}$

In order to estimate the relative danger of long-lived fission products the dose coefficients å (Sv/Bq) have been calculated from annual limits on intake of radionuclides by workers through stomach [2] and are included in the Table 1. Then the product A_t å may be considered as a measure of the relative danger of fission products after the storage time *t*. The danger of technetium-99 will be more than those of other fission products in the period between 560 and 800 000 years.

Thus technetium-99 is a most dangerous fission product after decay of strontium-90 and cesium-137. There is no good matrix to incorporate technetium-99. The most stable form of technetium in the nature is an ion TcO_4^- . This ion forms insoluble substances only with ions of cesium, rubidium and some organic cations. Therefore leach rates of technetium-99 from glasses are rather high. For example the leach rate 0.7 g/m^2 d has been found for UK-189 glass at 60^oC [3]. In Synroc technology technetium-99 is included in metal phase which is an alloy of technetium-99, molybdenum and some other metals [4]. The alloys of technetium with zirconium, niobium and molybdenum are superconductive with the high temperature of super conductivity. Technetium and its alloys have been shown to diminish the corrosion rate.

Technetium-99 is a pure â-emitter with E_{max} = 0,292 MeV and average energy 0,085 MeV. The specific activity of technetium-99 is equal to $6.3 \cdot 10^8$ Bq/g and the activity given in the Table 1 is corresponding to the mass 885 g/t U. The thermal capacity of technetium-99 is equal to $0.536 \cdot 10^{-5}$ W/g. The cross section of technetium-99 for thermal neutrons is rather small and equal to 20 barns [1]. Therefore transmutation of technetium-99 would be very expensive.

Perhaps the best solution of technetium-99 problem would be the application of metal technetium-99 or its alloys in nuclear reactor construction.

Literature.

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